*Note on Dr. H. A. Wilson's Memoir "On the Electric Effect of Rotating a Dielectric in a Magnetic Field."**

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While Dr. Wilson's experiments undoubtedly confirm the electron theory of Lorentz, as do the earlier experiments of Blondlot† on the motion of air through a magnetic field, to which Dr. Wilson does not refer, he has seriously misinterpreted this theory in stating that, according to it, the electromotive force induced in an insulator with dielectric constant K moving in a magnetic field bears the ratio $(K-1)/K$ to the electromotive force induced in a moving conductor. As a matter of fact, it is not the induced intensity or electromotive force which differs from substance to substance, and which differs according to different theories, but the displacement or charge produced by this intensity or electromotive force.

The calculation of the intensity or electromotive force induced in matter by its motion in a magnetic field, the "motional" intensity or electromotive force of Mr. Heaviside, is very simple on the theory of Lorentz. Thus, if an electron with charge q, a constituent of any kind of atom whatever, moves with velocity v in a magnetic field in which the induction is B, it will, in accordance with the law of Ampère applied to the convection current, be acted upon by a force

$$F = q\mathrm{V}v\mathrm{B}.$$

The force per unit charge upon the electron, or the motional intensity in the moving substance, is thus

$$e = F/q = \mathrm{V}v\mathrm{B},$$

and is wholly independent of the nature of the moving substance. Hence the induced or motional electromotive force, E, which is the line integral of the motional intensity e, is likewise independent of the nature of the moving substance.

Thus, instead of Dr. Wilson's equation,

$$E = n\pi(r_2^2-r_1^2)\,H\,(K-1)/K,$$

we have

$$E = n\pi(r_2^2-r_1^2)\,H,$$

H, the intensity of the magnetic field, being written for B, to which it is equal in magnitude.

* 'Phil. Trans.,' A, vol. 204, p. 121.

† 'Journal de Physique,' vol. 1, p. 8, 1902.

Hence, in place of Dr. Wilson's equation,

$$E = V(C+C')/C,$$

we have

$$E = V(C+C')/C \, . \, K/(K-1) \quad \text{or} \quad V = E(K-1)/K \, . \, C/(C+C'),$$

the result which is confirmed by Dr. Wilson's experiments, our $E(K-1)/K$ being equal to his E.*

When Dr. Wilson's abstract† appeared in America last July, I noticed at once the need for the above correction, but refrained from making it until the appearance of his complete memoir, hoping there to find the derivation of his curious result. The memoir, however, gives no derivation of the erroneous statement.

It may be of interest to state that in 1902 I started to construct apparatus for an investigation of this subject by a method different from Dr. Wilson's.

* To avoid ambiguity, let us write

$$\left(\frac{K-1}{K}\right) n\pi H(r_2^2 - r_1^2) = E,$$

the motional E.M.F. according to Dr. Wilson's theory, and

$$n\pi H(r_2^2 - r_1^2) = E_2,$$

the motional E.M.F. according to Lorentz. From these equations we get the relation

$$E = E_2\left(\frac{K-1}{K}\right).$$

Dr. Wilson's second equation on p. 123 of his memoir then becomes

$$-\frac{2Q}{K}\log\frac{r_2}{r_1} = -(V_2 - V_1) + E \quad \text{(Wilson)},$$

or

$$-\frac{2Q}{K}\log\frac{r_2}{r_1} = -(V_2 - V_1) + E_2\left(\frac{K-1}{K}\right) \quad \text{(Lorentz)}.$$

Making the transformations indicated by Wilson, we get

$$-\frac{Q}{C} = -V + E \quad \text{(Wilson)},$$

or

$$-\frac{Q}{C} = -V + E_2\left(\frac{K-1}{K}\right) \quad \text{(Lorentz)}.$$

And finally

$$V(C+C') = CE \quad \text{(Wilson)},$$

or

$$V(C+C') = CE_2\left(\frac{K-1}{K}\right) \quad \text{(Lorentz)}.$$

Now Wilson's experiments proved

$$\frac{V(C+C')}{C} \text{ equal to } E,$$

which is the same thing as proving

$$V\left(\frac{C+C'}{C}\right) \text{ equal to } E_2\left(\frac{K-1}{K}\right).$$

But E_2, not E, is the motional E.M.F. Thus the experiments proved V, or Q $\left(= -\frac{CC'}{C+C'} \, . \, E_2\left(\frac{K-1}{K}\right)\right)$, to be proportional to the E.M.F. in any theory and to $\frac{K-1}{K}$.

† 'Roy. Soc. Proc.,' June 2, 1904.

Lack of funds, however, put an early end to the work, and it has been resumed only lately with the aid of a grant from the Carnegie Institution.

Note on the Preceding Paper. By Professor LARMOR, F.R.S.

This paper is communicated by request of Dr. Barnett. The footnote inserted on p. 368 was received on March 23 in reply to a request for further information as to his meaning.

It would seem that objection is taken to Dr. Wilson's use of the somewhat ambiguous term electromotive force. It does not appear that Dr. Wilson's experimental result is disputed, nor is any other theoretical deduction offered in place of his one.

The proposition proved by Dr. Wilson is that rotation of a cylindrical condenser around its axis, in a longitudinal magnetic field, produces the same electromotive effect as if the condenser were at rest, and a potential difference equal to $(1-K^{-1})U$ were impressed between its coatings, *e.g.*, by connecting them through a battery of that electromotive force. In this expression U is the Faraday potential-difference that would be excited between the coatings of the rotating condenser if they were connected by a conducting wire that moved along with them. Dr. Barnett apparently wishes to omit this factor $1-K^{-1}$, and to rectify this omission by making the charge equal to the difference of potential multiplied by the capacity multiplied by $1-K^{-1}$.

If the moving dielectric were air, as in the experiment quoted from Blondlot by Dr. Barnett, the influence of the factor $1-K^{-1}$ of course could not be detected; the result must then in fact practically be the same, on any theory, as if the dielectric were vacuum.